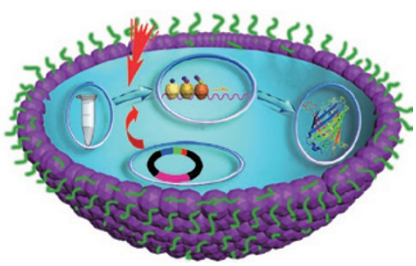
Expanding the 2D landscape

Phys. Rev. X **3,** 031002 (2013)

Although the rise of interest in the properties of graphene over the past decade has been remarkable, it also underlines a long-standing fascination that materials scientists and condensed-matter physicists have with 2D and layered crystals more generally. The latest systems to have gained widespread attention are the transition metal dichalcogenides such as MoS_2, which combine many of the appealing structural and electronic characteristics of graphene with semiconducting behaviour, a desired property for many technological applications. Doubtless there will be many more such 2D systems to come. Predicting quite how many and, more importantly, which materials are the most promising for experimental investigation, is the object of the latest study by Sébastien Lebègue and colleagues. By filtering structural data contained in the International Crystallographic Structural Database and combining this with first-principles numerical simulations to predict their electronic and magnetic properties, the researchers provide a glimpse to a far larger landscape of 2D crystals than previously imagined. *AT*

Protein–polymer capsules

Nature Commun. **4,** 2239 (2013)



Artificial, cell-like microcapsules made of lipids, polymers, peptides or colloidal particles have enabled huge progress in drug delivery, synthetic biology and biocatalysis, in part because they can be imbued with relevant functionality such as stimuli-responsiveness or selective permeability. Stephen Mann and colleagues now show that containers of amphiphilic protein–polymer conjugates have advantageous multifunctionality that may allow further technological developments in these fields. The researchers demonstrate that microdroplets of the conjugates self-assembled at the oil/water interface are elastic after being transferred to a water-based phase following polymer crosslinking and oil removal (they can be air-dried and rehydrated), can encapsulate hundreds of components and have temperature-dependent permeability to external proteins. These so-called proteinosomes are thus enzymatically active, and can serve as a gene-directed protein-synthesis container (a protocell) with temperature-switchable reaction rates. The researchers also show that the proteinosomes are robust to temperatures up to 70 °C for hours. *PP*

Sniffing out cancer

Adv. Healthcare Mater. http://doi.org/f2dkz9 (2013)

A human nose can selectively detect many different chemicals by means of a diverse set of olfactory receptors linked to sensory neurons. Mimicking this sensing capacity in devices termed bioelectronic noses could lead to the development of new sensing and diagnostic platforms. Now, Lim *et al.* have fabricated a bioelectronic nose consisting of single-walled carbon nanotube-based field-effect transistors (FETs) functionalized with olfactory nanovesicles that can selectively detect heptanal, a chemical biomarker present in the blood of lung-cancer patients. The specific human olfactory receptor that binds to heptanal was identified by a cell-signalling screening process. Then, mammalian cells expressing this olfactory receptor were used to produce nanovesicles containing the appropriate receptor on their surfaces. These nanovesicles were immobilized using charge–charge interactions on carbon nanotube channels within an FET device. The FET sensing system was shown to detect heptanal in samples of diluted human blood plasma spiked with the biomarker, at sufficiently sensitive concentrations that pre-treatment of the patients' blood would not be required in a clinical setting. *AS*

MOF patterns

Adv. Mater. http://doi.org/f2dmkc (2013)

Positioning or incorporating multifunctional metal–organic frameworks (MOFs) into miniaturized devices, such as in microfluidic or lab-on-a-chip devices, could lead to new technological applications involving MOFs. Now, Cara M. Doherty, Paolo Falcaro and colleagues demonstrate a versatile approach for fabricating MOF films, which could potentially be incorporated into devices using a generic patterning methodology applicable to all types of MOF. They use a facile protocol to pattern MOF films by combining ultraviolet lithography, hot pressing and pre-formed submicrometre-sized MOF crystals. The imprinting and lithographic processes are independent of each other and the resolution of the resulting patterned films depends on the size of the MOF crystals. The combination of these techniques can be used to achieve structural control of the resulting MOF films and does not affect their chemical functionality. This patterning protocol is in principle suitable for miniaturized catalytic, sensing, luminescent and biomedical devices, and is also scalable. *VD*

Two steps towards efficiency

Nature **499,** 316–319 (2013)

Perovskites ($CH_3NH_3PbX_3$, with X = Cl, Br, I) have recently gained attention as sensitizers for efficient, solution-processable photovoltaic devices. Such air-stable, fast electron-transporting materials have been used as a coating on mesoporous metal-oxide electrodes, leading to enhanced power-conversion efficiencies in solar cells. However, the standard coating method based on the deposition of a solution containing both the perovskite components PbX_2 and CH_3NH_3X suffers from poor control over the precipitation process and thus limited reproducibility of the photovoltaic performance. Michael Grätzel and colleagues now report a two-step deposition method: first, PbI_2 infiltrates uniformly into the nanopores of a TiO_2 film, and second, the film is dipped into a CH_3NH_3I solution and the PbI_2 is converted into perovskite pigments with a uniform size distribution. Solar cells with an improved photocurrent — due to the higher loading of the perovskite pigment in the TiO_2 film and an increased light scattering — and a power-conversion efficiency as high as 15% were realized. *LM*

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